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TO: Monica Lewis
Location: JEF 5A30
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Tuesday, September 28, 2004

Case Serial Number: 09/981277

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Search Notes

Examiner Lewis,

Attached are edited first pass search results from the patent and nonpatent databases.

Colored tags indicate abstracts especially worth your review.

If you need further searching or have questions or comments, please let me know.

Thanks,
Scott Hertzog

L11 ANSWER 23 OF 28 INSPEC (C) 2004 IEE on STN
AN 1997:5712419 INSPEC DN A9722-7570-016; B9711-3110M-030 Full-text
TI In situ and ex situ observation of **spin valves** obtained by ion-beam deposition.
AU Guarisco, D.; Kay, E.; Wang, S.X.
SO IEEE Transactions on Magnetics (Sept. 1997) vol.33, no.5, pt.2, p.3595-7.
Published by: IEEE
CODEN: IEMGAQ ISSN: 0018-9464

AB "Bottom" **spin valves** of the type NiO/15 AA NiFe/15 AA Co/tCu Cu/20 AA Co/50 AA NiFe were prepared by ion-beam deposition (IBD) on a Si(100)/NiO substrate. It is found that cleaning the substrates by **ion**-beam **etching** prior to the deposition of the multilayer has a significant influence on the magnetic properties of the **spin valve**. In particular, longer etching leads to a decrease in the exchange field and an increase in the coercivity of the pinned layer, without affecting the GMR ratio. A maximum GMR of 11.2% at room temperature is obtained for tCu=20 AA and 240 s etching time. The NiO substrate before and after **ion**-beam **etching** has been studied by atomic force microscopy (AFM). No significant change in roughness is observed, but the etched substrate shows smaller features.

CT ANTIFERROMAGNETIC MATERIALS; ATOMIC FORCE MICROSCOPY; COBALT; COERCIVE FORCE; COPPER; EXCHANGE INTERACTIONS (ELECTRON); FERROMAGNETIC MATERIALS; GIANT MAGNETORESISTANCE; INTERFACE STRUCTURE; IRON ALLOYS; MAGNETIC MULTILAYERS; NICKEL ALLOYS; NICKEL COMPOUNDS; SOFT MAGNETIC MATERIALS; SPUTTER DEPOSITION; **SPUTTER ETCHING**; SURFACE CLEANING; **SURFACE TOPOGRAPHY**

L19 ANSWER 5 OF 38 HCAPLUS COPYRIGHT 2004 ACS on STN
AN 2001:589460 HCAPLUS Full-text
DN 135:297356
TI Structural and magnetoresistive properties of Co/Cu multilayers
AU Marszalek, M.; Jaworski, J.; Michalik, A.; Prokop, J.; Stachura, Z.; Voznyi, V.; Bolling, O.; Sulkio-Cleff, B.
CS H. Niewodniczanski Institute of Nuclear Physics, Krakow, 31-342, Pol.
SO Journal of Magnetism and Magnetic Materials (2001), 226-230(Pt. 2), 1735-1737
CODEN: JMMMDC; ISSN: 0304-8853
PB Elsevier Science B.V.
AB Co/Cu multilayers (ML) were thermally evaporated at very low deposition rates on Si substrates covered with buffer layers of different metals (Ag, Cu, In, Pb, Bi). Structural characterization of samples was performed by x-ray reflectometry (XRR), XRD and atomic force microscopy (AFM). Magnetoresistance measurements were carried out at room temperature using a standard 4-probe d.c. method with current in the plane of the sample. It seems that a choice of buffer type has no significant effect on the magnitude of **GMR**. Since the thickness of single layers is of similar magnitude as the interfacial **roughness** in samples the authors suggest that the observed small value of **GMR** effect can be attributed rather to the interruption of film continuity and creation of magnetic bridges between Co layers, resulting in direct **ferromagnetic coupling** of magnetic films.
CC 77-1 (Magnetic Phenomena)
IT Evaporation
Ferromagnetic exchange
Giant magnetoresistance
Grain size
Interface **roughness**
Magnetic films
Magnetic multilayers
Magnetoresistance
Order
(structural and magnetoresistive properties of Co/Cu multilayers)

L11 ANSWER 27 OF 30 INSPEC (C) 2004 IEE on STN
AN 1996:5205731 INSPEC DN A9607-7570-041; B9604-3110M-008 Full-text
TI STM studies of **GMR** spin valves.
AU Misra, R.D.K.; Ha, T.; Kadmon, Y.; Powell, C.J.; Stiles, M.D.; McMichael, R.D.; Egelhoff, W.F., Jr.
SO Magnetic Ultrathin Films, Multilayers and Surfaces. Symposium
Editor(s): Marinero, E.E.; Heinrich, B.; Egelhoff, W.F., Jr.; Fert, A.;
Pittsburgh, PA, USA: Mater. Res. Soc, 1995. p.373-83 of xii+553 pp. 9 refs.
AB We have investigated the surface roughness and the grain size in giant magnetoresistance (**GMR**)spin valve multilayers of the general type: FeMn/Ni80Fe20/Co/Cu/Co/Ni80Fe20 on glass and aluminium oxide substrates by scanning tunneling microscopy (STM). The two substrates give very similar results. These polycrystalline **GMR** multilayers have a tendency to exhibit larger grain size and increased roughness with increasing thickness of the metal layers. Samples deposited at a low substrate temperature (150 K) exhibit smaller grains and less roughness. Valleys between the dome-shaped individual grains are the dominant form of roughness. This roughness contributes to the **ferromagnetic**, magnetostatic **coupling** in these films, an effect termed 'orange peel' coupling by Neel. We have calculated the strength of this coupling, based on our STM images, and obtain values generally within about 20% of the experimental values. It appears likely that the **ferromagnetic coupling** generally attributed to so-called 'pinholes' in the Cu when the Cu film thickness is too small is actually 'orange peel' coupling caused by these valleys.
CT COBALT; COPPER; FERROMAGNETIC MATERIALS; GIANT MAGNETORESISTANCE; GRAIN SIZE; IRON ALLOYS; MAGNETIC MULTILAYERS; MAGNETIC PARTICLES; MAGNETOSTATIC WAVES; MANGANESE ALLOYS; METALLIC SUPERLATTICES; NICKEL ALLOYS; SCANNING TUNNELLING MICROSCOPY; **SURFACE TOPOGRAPHY**
ST orange peel coupling; surface roughness; grain size; giant magnetoresistance; spin valve multilayers; scanning tunneling microscopy; substrate temperature; magnetostatic coupling; **ferromagnetic coupling**; film thickness; 150 K; FeMn-Ni80Fe20-Co-Cu-Co-Ni80Fe20

on hard copy in main STIC

L19 ANSWER 1 OF 38 HCAPLUS COPYRIGHT 2004 ACS on STN
AN 2002:303558 HCAPLUS DN 136:349548
TI Induced domain movement in **magnetic tunnel** junctions with sine-shaped small field modulations
AU Schmitz, Rolf
SO Berichte des Forschungszentrums Juelich (2001), Juel-3925, i-v, 1-124
CODEN: FJBEE5; ISSN: 0366-0885

AB First measurements on Barkhausen noise from **magnetic tunnel** junctions are presented. A low frequency magnetic field was applied to the magnetic thin film layers and then the temporary changes in the voltage signal of the junction were measured as spectral noise d. The alternating magnetic field causes a temporary change of the magnetization in the ferromagnetic layers. These changes influence the behavior of the resistance directly and the **TMR**-effect, resp. With this method it was possible to draw conclusions on the switching behavior of the magnetic domains in each magnetic layer. **Magnetic tunnel** junctions with a trilayer system made of Co/Al2O3/NiFe were fabricated. The Al2O3 barrier was fabricated using a Hg-low pressure lamp which was able to produce O radicals as well as O3 from pure O2 gas. This successful preparation method is concerned to be an alternative to the commonly used plasma oxidation All of the tunnel junctions showed a clear tunneling behavior based on the nonlinear current-voltage characteristics. The **tunneling magnetoresistance** effect of the junctions made with the UV-light were in the range of 10-20% at room temperature The magnetic switching fields were measured to 0.5 and 2 kA/m for the soft- and hard magnetic layers resp. To characterize the tunnel barrier, noise measurements at different applied magnetic fields were made. No significant changes were observed in the spectra of the UV-light oxidized and the plasma oxidized tunnel junctions. The surface **roughness** of Co and Al were also studied by x-ray diffraction and scanning force microscopy measurements. These showed clearly that a low Ar pressure during sputtering is responsible for the excellent **smoothness**. An rms-**roughness** was found which was less than 0.2 nm. **TMR** ratios of the UV-light oxidized barriers were investigated depending on the bias-voltage and temperature Furthermore, the O2 pressure was varied which was applied during the 1-h oxidation procedure of the Al. An optimal condition could be found at p = 10 mbar O2. Using this value the maximum **TMR**-ratios were received.

L9 ANSWER 1 OF 2 WPIX COPYRIGHT 2004 THOMSON DERWENT on STN
AN 2002-107691 [15] WPIX
DNN N2002-080169
TI Memory cell spin dependent tunneling junction for MRAM has upper ferromagnetic layer provided on top of insulating tunnel barrier which is provided on top of lower ferromagnetic layer.
DC U14
IN ANTHONY, T C; BHATTACHARYYA, M K; BRUG, J A; NICKEL, J; TRAN, L T
PA (HEWP) HEWLETT-PACKARD CO; (NICK-I) NICKEL J
CYC 28
PI EP 1132920 A2 20010912 (200215)* EN 10p G11C011-16
R: AL AT BE CH CY DE DK ES FI FR GB GR IE IT LI LT LU LV MC MK NL PT RO SE SI TR
JP 2001298228 A 20011026 (200215) 9p H01L043-08
US 2002047145 A1 20020425 (200233) H01L029-94 <--
ADT EP 1132920 A2 EP 2001-301769 20010227; JP 2001298228 A JP 2001-47766 20010223; US 2002047145 A1 Div ex US 2000-514934 20000228, US 2001-981277 20011017
PRAI US 2000-514934 20000228; **US 2001-981277** 20011017
IC ICM G11C011-16; H01L029-94; H01L043-08
ICS G11C011-14; G11C011-15; H01F010-14; H01F010-32; H01L027-105; H01L043-12
AB EP 1132920 A UPAB: 20020306
NOVELTY - An insulating tunnel barrier (40) is provided on top of a lower ferromagnetic layer (46) having flattened peaks. An upper ferromagnetic layer (48) is provided on top of the insulating tunnel barrier.
DETAILED DESCRIPTION - INDEPENDENT CLAIMS are also included for the following:
(a) a MRAM device for data storage;
(b) and a method for manufacturing MRAM.
USE - For magnetic random access memory (MRAM) for data storage.
ADVANTAGE - Reduction of storage capacity of MRAM device is prevented since unusable SDT junctions are eliminated. Increase in manufacturing cost is also prevented. Improves uniformity of resistance across MRAM device. Usable number of SDT junctions in MRAM device is also increased.
DESCRIPTION OF DRAWING(S) - The figure shows the diagram of an MRAM memory cell including spin dependent tunneling (SDT) junction.
Insulating tunnel barrier 40
Lower ferromagnetic layer 46
Upper ferromagnetic layer 48
Dwg.2/7
FS EPI
FA AB; GI
MC EPI: U14-A04; U14-A04A

L19 ANSWER 12 OF 38 HCAPLUS COPYRIGHT 2004 ACS on STN
AN 2001:187424 HCAPLUS DN 134:260268
TI Effects of annealing on the microstructure and giant magnetoresistance (**GMR**) of Co-Cu-based spin valves
AU Mangan, M. A.; Spanos, G.; McMichael, R. D.; Chen, P. J.; Egelhoff, W. F.,Jr.
CS Naval Research Laboratory, Washington, DC, USA
SO Metallurgical and Materials Transactions A: Physical Metallurgy and Materials Science (2001), 32A(3), 577-584
CODEN: MMTAEB; ISSN: 1073-5623
PB Minerals, Metals & Materials Society
AB The effect of annealing on the microstructure and giant magnetoresistive properties of NiO/Co/Cu/Co bottom spin valves was studied by conventional and high-resolution TEM. The value of the **GMR** of these spin valves decreases from 12.2 to 2.7% after annealing in a vacuum for 30 min at 335°. This decrease is attributed to an increase in the **roughness** of the Co and Cu layers. In annealed specimens, grain boundary grooving is also observed in the antiferromagnetic NiO pinning layer at the NiO/Co interface, and the location of these grooves correlates with **waviness** in the Co/Cu interfaces. An increase in the Neel orange peel **coupling** between the **ferromagnetic** Co layers, resulting from the increased **roughness** of the Co/Cu interfaces, accompanies the degradation of the **GMR**.

L19 ANSWER 18 OF 38 HCAPLUS COPYRIGHT 2004 ACS on STN
AN 1997:779027 HCAPLUS DN 128:109012
TI Oxygen as a surfactant in the growth of giant magnetoresistance spin valves
AU Egelhoff, W. F., Jr.; Chen, P. J.; Powell, C. J.; Stiles, M. D.; McMichael, R. D.; Judy, J. H.; Takano, K.; Berkowitz, A. E.
SO Journal of Applied Physics (1997), 82(12), 6142-6151
CODEN: JAPIAU; ISSN: 0021-8979
PB American Institute of Physics
AB The authors found a novel method for increasing the giant magnetoresistance (**GMR**) of Co/Cu spin valves using O. Surprisingly, spin valves with the largest **GMR** are not produced in the best vacuum. Introducing 5+10-9 Torr (7+10-7 Pa) into the authors' ultrahigh vacuum deposition chamber during spin-valve growth increases the **GMR**, decreases the **ferromagnetic coupling** between magnetic layers, and decreases the sheet resistance of the spin valves. Apparently the O may act as a surfactant during film growth to suppress defects and to create a surface which scatters electrons more specularly. Using this technique, bottom spin valves and sym. spin valves with **GMR** values of 19.0 and 24.8, resp., were produced. These are the largest values ever reported for such structures.
IT Crystal defects
Ferromagnetic exchange
Giant magnetoresistance
Interface **roughness**
Sheet resistance
Sputtering
Surfactants
(oxygen as surfactant in growth of cobalt/copper spin valves with giant magnetoresistance)

L19 ANSWER 14 OF 38 HCAPLUS
AN 2000:231230 HCAPLUS DN 132:317108
TI Nature of coupling and origin of coercivity in giant magnetoresistance NiO-Co-Cu-based spin valves
AU Chopra, Harsh Deep; Yang, David X.; Chen, P. J.; Parks, D. C.; Egelhoff, W. F., Jr.
SO Physical Review B: Condensed Matter and Materials Physics (2000), 61(14), 9642-9652
CODEN: PRBMDO; ISSN: 0163-1829
AB The effect of various couplings on the switching field and coercivity in NiO-Co-Cu-based giant magnetoresistance (**GMR**) bottom spin valves is investigated. Bottom spin valves as well as different layer permutations that make up a bottom spin valve, viz., Co single films, Co/Cu/Co trilayers, and Co/NiO bilayers (deposited under similar growth conditions), were investigated for their magnetic, crystal, and interfacial structure. As-deposited bottom spin valves exhibit a large **GMR** of ≈16.5%, and a small net **ferromagnetic coupling** (+0.36 mT) between the "free" Co layer and the NiO-pinned Co layer. The high resolution transmission electron microscopy (HRTEM) and in situ scanning tunneling microscopy (STM) studies on spin valves and trilayers show that the average grain size in these films is ≈20 nm and average **roughness** ≈ 0.3 nm. Using these values, the observed **ferromagnetic coupling** in spin valves could largely be accounted for by Neel's so-called "orange-peel" coupling. Results also show that the "free" Co layer exhibits an enhanced coercivity (HcFree-Co=6.7 mT) with respect to Co single films of comparable thickness (HcCo=2.7 mT). The TEM studies did not reveal the presence of any pin-holes, and "orange-peel" or oscillatory exchange coupling mechanisms cannot adequately account for this observed coercivity enhancement in the "free" Co layer of spin valves. The present study shows that the often observed and undesirable coercivity enhancement in the "free" Co layer results from magnetostatic coupling between domain walls in the "free" Co layer and high coercivity NiO-pinned Co layer (HcPinned-Co≈45 mT); without NiO, the coercivity of Co layers in the corresponding Co/Cu/Co trilayer remains largely unchanged (HcCo/Cu/Co=3.0 mT) with respect to Co single films. Evidence of magnetostatically coupled domain walls was confirmed by direct observation of magnetization reversal, which revealed that domain walls in the "free" Co layer are magnetostatically locked-in with stray fields due to domain walls or magnetization ripples in the high coercivity NiO-pinned Co layer of the spin valves. The observed escape fields (defined as fields in excess of intrinsic coercivity of Co single film that are required to overcome magnetostatic coupling between domain walls) are in agreement with theor. calculated values of escape fields.

L19 ANSWER 17 OF 38 HCAPLUS COPYRIGHT 2004 ACS on STN
AN 1998:179875 HCAPLUS DN 128:288807
TI Microstructural modification in Co/Cu giant-magnetoresistance multilayers
AU Christides, C.; Stavroyiannis, S.; Boukos, N.; Travlos, A.; Niarchos, D.
SO Journal of Applied Physics (1998), 83(7), 3724-3730
CODEN: JAPIAU; ISSN: 0021-8979
AB Three different classes of [Co/1.1 nm/Cu/2.1 nm]30 multilayers were grown by magnetron sputtering deposition. The effect of magnetostatic interactions on the giant magnetoresistance (**GMR**) and magnetic properties are examined in relation to the induced changes in the film microstructure as it is varied by: (i) the substrate surface **roughness** and (ii) the effect of thermal isolation of the Si(100) substrate from the cooling plate during deposition. A remarkable variation in shape and magnitude of **GMR**, and in the magnetic (M-H) loops, is observed for the three classes of films. It is found that there are three characteristic features in every sample that vary systematically: (i) the $(\Delta R/R)$max ratio, (ii) the magnetic field range where a **GMR** loop reaches its min. value, (iii) the (M-H) loops that vary from the characteristic antiferromagnetic to a typical ferromagnetic loop shape. Two well-separated grain size distributions below and above 12 nm were found from transmission electron microscopy. The smaller grains are associated with the appearance of a considerable fraction of **ferromagnetically coupled** regions in the multilayer.

L19 ANSWER 21 OF 38 HCAPLUS COPYRIGHT 2004 ACS on STN
AN 1996:592293 HCAPLUS DN 125:236548
TI Quenching of giant magnetoresistance by interface **roughening** and alloying in annealed [(NixFe1-x)yAu1-y]/Au multilayers
AU Farrow, R. F. C.; Parkin, S. S. P.; Marks, R. F.; Krishnan, Kannan M.; Thangaraj, N.
SO Applied Physics Letters (1996), 69(13), 1963-1965
CODEN: APPLAB; ISSN: 0003-6951
AB Antiferromagnetically coupled permalloy/Au multilayers display giant magnetoresistance (**GMR**) with large changes in resistance in very low fields. Thermal annealing of such structures, exhibiting **GMR** , leads to a quenching of the magnetoresistance. The detailed structure of the permalloy/Au interfaces was probed using high-resolution cross-section TEM. On annealing, the Au layers interdiffuse into the permalloy layers, which leads both to **rougher** permalloy/Au interfaces and to thinner Au spacer layers. The authors infer that the latter results in **ferromagnetic coupling** of the permalloy layers, which accounts for the reduced **GMR**.